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UNITED STATES DEPARTMENT OF AGRICULTURE

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JOHN R. MOHLER, Chief

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UNIT REQUIREMENTS FOR PRODUCING MILK IN WESTERN WASHINGTON.

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CHARACTER AND SCOPE OF THE WORK.

What does it cost to produce milk? This is a question which has brought increasing concern to each dairyman as the cost of feed has increased and hired men are being attracted to other industries paying higher wages. The United States Department of Agriculture, through the Dairy Division of the Bureau of Animal Industry, began a series of studies in 1915 intended to give the dairymen of the United States information on the cost of producing milk. These studies were made in different sections of the United States. The project with which this bulletin deals was organized in August, 1917, in Skagit County, Wash., about 70 miles north of Seattle.

Other objects of these studies were to separate and analyze various factors to obtain data which would aid in improving general milk-production methods.

The climate and fertility of the soil in this section produce exceptionally good pasturage throughout the larger part of the year. The many herds of black and white cattle grazing over the large ex-

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panse of low-lying meadows, together with the numerous windmills dotting the landscape, remind an observer of the description of the Holstein breed in its native country.

At the end of the first year the work was discontinued until January, 1919, because of the war. The value of this work to the dairymen cooperating the first year is reflected in the fact that 15 out of the 17 continued the work for the second year. Two dairymen sold out, and their places were taken by neighboring dairymen during the second year. The data obtained in this study are actual records of facts obtained by regular monthly full-day visits to 15 farms for two years and four other farms for one year.

Most of the milk in this section is sold for condensing purposes and is delivered by motor truck to large milk condenseries. None of the dairies selected were conducted as hobbies or as breeding establishments, but were representative of average dairy conditions found in this section. It is the custom to hire milkers, who milk and take care of 25 or 30 cows per man and give their entire time to the herd. The figures reported show the amounts expended in producing milk under the system of dairy management found.

The dairies were inspected by representatives from the condenseries, and the sanitary conditions were subject to such supervision. The cost of production would have been somewhat different if either higher or lower grades of milk had been produced.

METHODS USED IN OBTAINING THE DATA.

The field agent recorded in detail all available information[1] relative to the dairy business, including the amounts and classes of labor, feeds and bedding used, pasture cost, amount of milk sold and used on the farm, and the current expenses for the month. The data on calves and handling of manure were systematically collected.

By obtaining records on every dairy regularly each month the influence of unusual circumstances at the time of any particular visit was lessened, and by using the records of all the herds for each month average figures could be compiled for each or all of the dairies and representative data for each month, season, and year were thus obtained. Records were obtained the second year as a check on the first year's work and to increase the amount of data available for study.

At the beginning and end of each year an inventory was taken of the dairy buildings, livestock, and equipment used in the care of the herd and its products. On his regular monthly inspection tour the field agent arrived at the first farm of a group in time to observe the first labor operations connected with the evening chores. With

[1] Copies of the blanks used can be obtained upon request from the Bureau of Animal Industry, Dairy Division, Washington, D. C.

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watch in hand he noted and recorded the exact minute each labor operation connected with the dairy was begun and ended. The labor operations during the next morning were recorded in the same manner, to complete the 24-hour period.

The field agent also noted the feeds that were being fed on the day of his visit, recording the kind, quantity, cost, and description of each and comparing them with the quantity recorded by the cow tester in the cow-testing-association books.

The quantity of milk sold and receipts each month were obtained. In addition the whole milk used by the proprietor and his help or fed to calves was measured or weighed and used as a basis for determining the quantity kept on the farm during the month.

Each dairyman kept an itemized account of expenses that were incurred between the monthly visits, and these items were recorded by the field agent. A monthly record was also kept of the purchase or sale of cows, calves, hides, outside bull service, and other miscellaneous information relating to the herd. The condition and method of handling the manure were noted and reported each month.

When all the labor operations about the dairy had been completed for the day at the first farm, the field agent drove to the second farm in time to observe the labor operations connected with the evening chores. This program was followed until Saturday afternoon, when he returned to his headquarters and finished his reports for the week's work. The same program was followed each week in the month, and each farm was visited for a full day every 30 days throughout the two years.

COMPARISON OF WINTER AND SUMMER RESULTS.

Since the winter and summer seasons have a marked influence on the principal factors entering into the cost of producing milk, the results have been computed separately for those periods. The months from November to April, inclusive, represent the winter season and from May to October the summer season. This division of time was based directly on the change in methods of herd management made in November and May.

The various tables found in this bulletin are based upon figures obtained during two years of study, and the weighted average of the two-year records was used whenever it would more accurately express the result. The weighted average was obtained by giving each item a weight in the average according to its relative importance.

DESCRIPTION OF HERDS.

During the first year records were obtained on 17 herds, having an average size of 31.3 cows, with an average annual production of 7,369 pounds of 3.74 per cent milk per cow. During the second year, 18 herds, 15 of which had been in the first year's work, had an average

size of 28.6 cows, and produced an average of 8,323 pounds of 3.59 per cent milk per cow. The cows were mostly Holsteins, and the average annual production for both years was 7,833 pounds of 3.66 per cent milk. During the first year the pastures were poorer than they had been for years, whereas during the second year they were exceptionally good until the last month, when the herds were pastured on the second-growth meadows. As a matter of record, many herds grazed on pastures in which the clover stood a foot high—high enough to be cut for hay. The extreme variation in the condition of the pastures during the two seasons largely accounts for the increase of 954 pounds of milk per cow during the second year.

For each 100 cows in the herds during the two years, 55 freshened during the winter six-months period and 42 during the summer season, while 3 cows did not calve during the year. During the first year the cows dropping calves in winter were dry 1.9 months, while those cows dropping calves in summer were dry 1.4 months. The corresponding figures for the second year were 2.2 months in winter and 1.5 months in summer. Nearly one-half of the cows freshening dropped their calves during the months from February to May, inclusive.

REQUIREMENTS FOR PRODUCING 100 POUNDS OF MILK.

The unit requirements for producing 100 pounds of milk during this investigation are shown in Table 1. In order to secure more uniform results and to overcome the effect of fluctuating prices, money values have been eliminated as much as possible. By showing the feeds in terms of pounds and the labor in terms of hours it will be possible to use these figures for some time to come.

TABLE 1.—*Units required, except cost of management, for producing 100 pounds of milk in winter and in summer.*

Item.	Winter.		Two winters.	Summer.		Two summers.
	1917–18	1919–20		1917–18[1]	1919	
Feed:						
Purchased concentrates.....pounds..	25.8	18.8	22.1	4.3	4.9	4.6
Home-grown grains.....do....	1.1	12.9	7.3	.....	1.1	.6
Total concentrates.....	26.9	31.7	[2] **29.4**	4.3	6.0	**5.2** [2]
Hauling and grinding concentrates....	$0.016	$0.028	**$0.022**	$0.002	$0.004	**$0.003**
Noncommercial roughage....pounds..	.9	10.2	5.8	.....	.2	.1
Commercial carbohydrate hay..do....	90.1	70.0	79.5	4.4	9.0	6.8
Legume hay.....do....	3.1	11.7	7.6	.3	.8	.6
Total dry roughage.....	94.1	91.1	**92.9**	4.7	10.0	**7.5**
Silage and other succulent roughage.....pounds..	156.8	131.1	**143.3**	42.7	38.2	**40.4**
Pasture.....acres..	.....	.....	.....	.027	.02	.025
Bedding.....pounds..	12.4	5.9	**9.0**	.....	.2	.1

[1] This season consisted of September, and October, 1917, and May, June, and July, and August, 1918.
[2] The summary of the unit requirements by seasons is printed in bold-faced type for convenience of the reader.

TABLE 1.—*Units required, except cost of management, for producing 100 pounds of milk in winter and in summer*—Continued.

Item.	Winter.		Two Winters.	Summer.		Two summers.
	1917–18	1919–20		1917–18	1919	
Labor:						
Human.....hours..	2.0	1.8	1.9	1.3	1.3	1.3
Horse.....do....	.01	.01	.01	.01	.02	.015
Other costs:						
Building charges.....	$0.124	$0.130	$0.127	$0.085	$0.092	$0.088
Equipment charges and dairy supplies	.088	.088	.088	.060	.062	.061
Herd charges: Taxes, insurance, veterinary, medicines, disinfectants, and cow-testing associations.....	.043	.034	.038	.029	.024	.026
Interest on cow investment.....	.118	.108	.113	.080	.076	.078
Cost of keeping bull.....	.078	.074	.076	.042	.042	.042
Motor-truck charge.....	.....	.....	.....	.....	.001	.....
Cash hauling of milk.....	.066	.065	.062	.067	.062	.061
Total other costs, except depreciation on cows.....	.517	.499	.504	.363	.359	.356
Depreciation on cows.....	.144	.007	.072	.098	.005	.050
Total other costs.....	$0.661	$0 506	$0.576	$0.461	$0.364	$0.406

It will be noted in Table 1 that for producing 100 pounds of milk in the first winter there were required 26.9 pounds of grain, while during the second winter 31.7 pounds were required, an increase of 4.8 pounds. For dry roughage there is a decrease of 3 pounds, and for succulent roughage a decrease of 25.7 pounds per 100 pounds of milk. This increase in grain and decrease in dry and succulent roughages can be accounted for by the fact that two of the herds that were sold out the first year consumed very little grain but a large quantity of roughage.

Since the pastures were of a very excellent quality summer feeding of grain was not followed extensively. Some of the best-producing herds received no grain throughout the summer, which accounts for the low average of 5.2 pounds of grain per 100 pounds of milk during the summer seasons.

While there was a slight advance in prices for both hauling and grinding concentrates during the second year, the increase for these charges per 100 pounds of milk from 16 cents to 28 cents in the winter and from two-tenths of a cent to four-tenths of a cent in the summer of the first and second years, respectively, is due primarily to the increase in the quantity of feeds ground rather than to the advanced rate of hauling and grinding.

The work of collecting milk through this section is thoroughly organized. The milk, shipped in 10-gallon cans, is collected once daily by motor truck. On the return trip the truck brings back the empty cans, which makes it unnecessary to have two sets of cans. As the roads are very good it is not uncommon, in the season of greatest production, for a motor truck and trailer to haul 100 cans. The efficiency

of the truck method of hauling milk is shown by the very low cost of 6.2 cents per 100 pounds of milk in winter and 6.1 cents per 100 pounds of milk in summer. The use of the motor truck also accounts for the small amount of horse labor.

The cost of keeping a bull includes feed, labor, and other costs expressed in dollars. For closer study a table will be found on page 10 expressing the costs in terms of pounds and hours.

REQUIREMENTS FOR KEEPING A COW ONE YEAR.

The greater production per cow, in summer, of 1,399 pounds of milk, shown in Table 2, is partly due to a larger percentage of cows freshening in the winter and early spring, but more particularly it is the direct result of good pastures. The value of this pasture is especially noticeable when one observes that in winter the cows required 946 pounds of grain to produce 3,217 pounds of milk, while in summer they required only 241 pounds of grain to produce 4,616 pounds of milk.

TABLE 2.—*Number of cows, average production per cow, and requirements for keeping a cow during each season and for the entire year, except cost of management, based on records of the two years' work.*

Item.	Winter.	Summer.	Entire year
Number of cows	1,043.1	1,049.3	1,046.2
Average production per cow.....pounds..	3,217	4,616	7,833
Feed:			
Purchased concentrates.....do....	711	214	925
Home-grown grains.....do....	235	27	262
Total concentrates.....do....	946	241	1,187
Hauling and grinding concentrates	$0.72	$0.15	$0.87
Noncommercial roughage.....pounds..	186	4	190
Commercial carbohydrate hay.....do....	2,558	314	2,872
Legume hay.....do....	246	28	274
Total dry roughage.....do....	2,990	346	3,336
Silage and other succulent roughage.....do....	4,610	1,864	6,474
Bedding.....do....	289	6	295
Pasture	$1.70 (or 0.1 acre.)	$21.34 or 1 acre.	$23.04 or 1.1 acres.
Labor:			
Human.....hours..	60.1	60.9	121.0
Horse.....do....	.29	.67	1.0
Other costs:			
Building charges	$4.10	$4.07	$8.17
Equipment charges and dairy supplies	2.34	2.33	4.67
Herd charges: Taxes, insurance, veterinary, medicines, disinfectants, and cow-testing associations	1.22	1.22	2.44
Interest on cow investment	3.62	3.60	7.22
Cost of keeping bull	2.44	1.94	4.38
Motor-truck charge		.04	.04
Cash hauling of milk	1.98	2.82	4.80
Total other costs, except depreciation on cows	15.70	16.02	31.72
Depreciation on cows	2.30	2.29	4.59
Total other costs	$18.00	$18.31	$36.31

The one-tenth of an acre pasture charge shown for winter represents supplementary pasture or pasture on meadows in spring and second-crop meadow and grain stubble in the fall. In case the oats are lodged fall pasture furnishes a valuable source of feed. In

spring it is a common practice in this dairy section to turn the cows in the meadows for a short time, thereby obtaining a shorter but finer hay crop, which is a decided advantage when hay is inclined to grow tall and coarse.

The small quantity of bedding used was due to the fact that the winters were so mild that the cows were kept in the barn only during January, February, and March, while at least three of the herds received practically no bedding.

The hours of labor expended per cow in summer and in winter did not differ materially. The time required in winter for feeding and for cleaning stables was used in summer for driving the cows to and from pasture; also in summer more time was necessary for milking on account of increased production.

CREDIT FOR MANURE.

On the average dairy farm the commercial value of manure depends upon the use to which it is put. The return in dollars depends upon the increase in the crops raised and in the amount received from the sale of these crops. These facts may reduce or increase the value of manure below or above the market price of the fertilizing constituents contained in it.

The farming land in many parts of western Washington is reclaimed swamp land and the soil is unusually fertile. Dairymen therefore derived very little benefit from the application of manure and did not place a high valuation on it. The credit for the manure, however, which was the same for summer and winter, was based on the market price of the fertilizing constituents contained in it.

The prices per pound of the fertilizing constituents in the manure for the first year were as follows: Nitrogen, $0.25; commercial phosphoric acid, $0.06; and potash, $0.068. The prices during the second year were $0.191 for nitrogen, $0.056 for phosphoric acid, and $0.068 for potash.

Only that manure which was saved or could have been saved under ordinary farm conditions was credited to the cows. In order to determine the amount of manure saved, a monthly record was kept of the time the cows were actually in the stables. This made it possible to figure the weight of manure voided in the barns, for, according to the best authorities, a 1,000-pound cow will produce 13 tons of manure in a year, or 6½ tons for six months. The manure dropped on the pasture was not credited to the herds; if a credit had been given, an offset charge against the pasture for fertilizer would have been necessary.

Many of the stables had holes in the gutters to permit the liquid to escape; therefore a deduction was made wherever necessary to cover this loss. Also a deduction of 25 per cent in the summer and 30 per cent in the winter, or rainy season, was made to cover the loss to the manure while in the yard exposed to the weather.

To determine the fertilizing constituents in the manure the feeds used throughout the winter were classified so that their average composition could be obtained. This was done by referring to standard tables containing the analyses of the various classes of feeds.

Since a cow in the process of digestion utilizes on the average only approximately 25 per cent of the nitrogen, 30 per cent of the phosphorus, and 15 per cent of the potash, it is evident that 75 per cent of the nitrogen, 70 per cent of the phosphorus, and 85 per cent of the potash is available for fertilizers. By knowing the weights of the feeds and their average composition it was possible to determine the approximate amounts of the three fertilizing elements consumed. From these figures deductions were made for that utilized by the cows to obtain the total amounts of the fertilizing elements voided. In figuring the amount of fertilizing constituents saved the same factors were considered that determined the weight of manure credited to cows, namely, the time the cattle were out, making the fertilizer unreclaimable, the amount of liquid lost through holes in the gutters, and the loss in leaching while stored in the yards.

A ton of average manure during the winter was estimated to have the following constituents:

	Pounds.
Nitrogen	9.9
Commercial phosphoric acid	4.2
Potash	11.5

No credit was allowed for bedding, as the large acreage of oats and a superabundance of straw from the fertile soil makes the farm price of the straw less than the value of the fertilizing constituents in it. The farm price of the straw is little more than enough to pay for bringing the straw to the barn. It might be hauled directly from the stack to the field instead of the barn, thereby distributing the fertilizing elements on the soil at the same expense.

TABLE 3.—*Manure and fertilizing constituents credited to the herds during the two winters and the two summers.*

Item.	Winter.			Summer.		
	1917–18	1919–20	Average.	1917–18 [1]	1919	Average.
Total manure saved.....tons..	1,128.2	802.3	965.2	179.1	126.8	153.0
Manure per cow.....pounds..	4,200.0	3,200.0	3,800.0	600.0	400.0	600.0
Manure credited per 100 pounds of milk, pounds.....	.....	.....	115	.....	.....	13
	Winter average.			Summer average.		
	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
Fertilizing constituents in manure, pounds.....	9,474	4,003	11,134	1,500	634	1,765
Credit per cow.....pounds..	18.2	7.7	21.3	2.9	1.2	3.4

[1] The summer of 1917–18 included the months of September and October, 1917, and May, June, July, and August, 1918.

The low credit per cow for manure is due to the small quantity of manure saved and to the losses incurred in handling it. Since the cost of keeping a bull was charged against the cows under other costs, the bull manure was credited to the herds and included in the credit of 2.1 tons of manure per cow in 1917–18 and 1.6 tons per cow in 1919–20.

CREDIT FOR CALVES.

The seasonal variations in the production of calves show a small increase in the number of calves dropped in winter over the number dropped in summer, but this does not imply that winter dairying was emphasized. A study of the number of calves dropped per month shows that there were more calves born from January to May than during any other corresponding period, which indicates a tendency toward summer dairying.

TABLE 4.—*Total credit for calves produced, by years and by seasons.*

Item.	Credit by years.		Credit by seasons.	
	1917–18	1919–20	Both winters.	Both summers.
Number of calves	514	502	574	442
Total value of calves	$3,399.89	$4,821.11	$4,495.38	$3,725.62
Average value of calves	$6.61	$9.60	$7.83	$8.43
Calves per cow	0.96 of 1 calf.	0.98 of 1 calf.	1.1 calves.	0.84 of 1 calf.
Credit per cow	$6.38	$9.39	$8.61	$7.08
Credit per 100 pounds of milk	0.013 of 1 calf.	0.012 of 1 calf.	0.017 of 1 calf.	0.009 of 1 calf.

The average production of 0.96 of one calf per cow for the first year and 0.98 of one calf for the second year shows a very high average, which ordinarily can not be expected. Their increase in value was wholly due to a rise in the market value of calves.

The greater number of calves were sold for veal when very young. Each calf that was raised was given a value by the farmer, who took into consideration the individual and its breeding. As grade prices were given to the purebred cows, their calves were given a value which corresponded to a grade calf of similar quality. This was done because in these studies the breeding business was separated from the business of producing milk.

REQUIREMENTS FOR KEEPING A BULL.

There is a noticeable difference in both feed and labor requirements for keeping a bull in summer and in winter. On 10 farms the bulls ran on pasture or were tethered out. This accounts for the low feed requirements, other than pasture, and for the low labor requirements for the summer season.

The small quantity of bedding was due to a combination of reasons. In many herds the bulls ran with the cows, and they were kept in the stable only at night during January, February, and March. A

number of the bulls received no bedding at all, and in one instance where the bull was kept separate his stall was bedded with the refuse hay from his manger.

TABLE 5.—*Requirements for keeping a bull, by seasons, based on averages obtained from the equivalent of 34.4 bulls.*

Item.	Winter.	Summer.	Entire year.
Feed:			
Purchased concentrates.....pounds..	280	166	446
Home-grown grain.....do....	129	55	184
Total concentrates.....do....	409	221	630
Noncommercial roughage.....do....	339	208	547
Commercial carbohydrate hay.....do....	3,360	1,790	5,150
Legume hay.....do....	193	77	270
Total dry roughage.....do....	3,892	2,075	5,967
Succulent roughage.....do....	1,669	1,400	3,069
Bedding.....do....	31	12	43
Pasture.....	$1.68	$11.88	$13.56
Human labor.....hours..	24.0	16.4	40.4
Other costs:			
Interest and insurance on bull investment.....	$10.54	$10.48	$21.02
Bull's share of buildings.....	4.06	4.09	8.15
Depreciation.....	6.36	6.28	12.64
Total other costs.....	20.96	20.85	41.81
Credit for outside bull service.....	10.22	10.10	20.32
Total other cost less outside bull service.....	10.74	10.75	21.49

Table 5 shows an annual depreciation of $12.64 per bull per year. Most of the bulls were purebred and were purchased when young at purebred prices. As they grew older their values increased. This appreciation in value helped to decrease the depreciation on old bulls sold for beef for less than their purebred value.

A credit for outside bull service of $20.32 per year was due to service fees obtained from four of the bulls in the association, one of which was an animal of special merit. However, the large credit for outside service for this bull was partly offset by the increased charges for interest, insurance, and depreciation. If both the "other costs" of keeping the bull and the credit for outside service had been stricken from the records, the net "other costs" per year for keeping the other bulls would have averaged $31.69.

FACTORS INVOLVED IN THE PRODUCTION OF MILK.

FEED.

Concentrates is a term applied to grains and to their manufactured by-products which contain a large amount of nutritious substance in a relatively small bulk.

Home-grown grains refer to concentrates grown on the farm or in the locality where fed.

Dry roughage includes various hays and other rough feeds, which are subdivided into the three following classes:

Noncommercial dry roughage applies to coarse feeds, such as corn stover and velvet-grass hay, for which price quotations are not given in the trade papers. Hay or other dry roughage so foul with weeds or so damaged in curing as not to be readily salable is also classified under this heading.

Leguminous roughage includes alfalfa, clover, cowpea, soy bean, and other commercial legume hays, when pure, or when so slightly mixed with grasses as not materially to affect the protein content.

Commercial carbohydrate roughage refers to all commercial hays except those classified as leguminous roughage.

Succulent roughage consists of mangels, potatoes, silage, and soiling crops.

The quantities of the various feeds used were obtained from actual weights made by the field agent on his regular monthly visit to each farm.

Purchased concentrates were charged at the prices paid, less the value of the sacks in which they were purchased. These sacks were readily salable if not desired for use on the farm and were given the same value for which they could have been sold. The home-grown grains were given the farm price plus such extra charges as hauling and grinding when necessary. When baling or hauling dry roughage was necessary the price for such was deducted from the market value of the feed. If the succulent roughage was salable the farm price was used in determining valuations per ton; however, if it was not salable a price which was commensurate with its value as compared with the value of a marketable product was placed on it.

PASTURE.

In western Washington pasture plays a very important part in milk production. With cool weather throughout most of the summer, plenty of moisture, and a rich soil there is abundant pasture until late in the fall. During the pasture season almost 60 per cent of the milk for the year was produced and at one-third the yearly feed cost.

The charges against pasture consist of interest, taxes, upkeep, and repairs on fences, cutting thistles and weeds, and seeding.

Interest was figured on the unimproved value of the land, which was obtained by deducting from the improved value any increase in worth due to the dairy buildings contributary to it. The rate of interest allowed varied from 6 to 8 per cent. The rate was determined by the per cent the farmer would have to pay if he borrowed money to buy the land.

The amount of the taxes on the whole farm was ascertained from the books of the county authorities; from this the amount incidental to pasture was calculated.

Upkeep and repairs to fences were largely an approximation. They were determined by asking the farmers the value and life of posts, wire, etc., and the labor required to build and keep the fences in repair. From these data the annual cost was computed.

Cutting thistles and weeds is a necessary operation on most of the pastures; where this was the case the cost for such was included in the pasture charge. A seeding charge was allowed where the pasture takes a regular place in the crop rotation, for in this way the pasture derives some of the benefit from the seeding for meadow.

The annual pasture rent per cow amounted to 1.1 acres, or $23.04.

LABOR.

The average labor rate per hour was obtained by dividing the wages per month, plus such extra considerations as board, house rent, milk, and fuel, by the total number of hours available for work.

The hours available for work during the month were determined on the monthly visit to each farm. The times work began in the morning and when it ceased in the evening were noted, and from the period of work was subtracted the time out for meals and rest. The hours per day thus obtained were multiplied by the number of working days in that month, to which were added the hours of work necessary on Sundays.

TABLE 6.—*Per cent of labor performed and hours per 100 pounds of milk produced for each class of help.*

Class of labor.	Winter.				Summer.			
	Distribution of work performed.			Labor per 100 pounds of milk.	Distribution of work performed.			Labor per 100 pounds of milk.
	1917–18	1919–20	Average.	Average.	1917–18	1919	Average.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Hours.*	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*
Managers	27.5	23.8	25.6	0.48	26.7	27.3	27.0	0.36
Hired men	62.4	66.1	64.2	1.20	60.3	58.1	59.2	.78
Total man labor	89.9	89.9	89.8	1.68	87.0	85.4	86.2	1.14
Women	2.5	1.0	1.8	.03	2.9	1.1	2.0	.03
Boys	7.6	9.1	8.4	.16	10.1	13.5	11.8	.16
Total	100.0	100.0	100.0	1.87	100.0	100.0	100.0	1.33

Table 6 shows that 64.2 per cent of the work during the two winters and 59.2 per cent of the work during the two summers was performed by hired men. It is a practice in that part of the country, especially with the larger dairies, to hire a man and put him in charge of the dairy. The men who follow this line of work are for the most part of Scandinavian or Swiss descent. They become very proficient and make excellent dairymen. They follow regular schedules for doing their work and develop a wonderful capacity for

milking. During the first year six dairies were handled by these professional milkers, and each man had an average of 32.8 cows in his "string" which he fed and milked alone. During the second year the average "string" consisted of 28.8 cows.

In two of these dairies the milkers were accustomed to be at the barn and ready to start their work at 2 o'clock in the morning. At other farms the time for starting work ranged from 2.30 to 4 o'clock.

The number of cows which a man can care for depends largely upon the quantity of milk they are producing, but usually it ranges between 18 and 30. A specific instance is known where one man milked 42 cows twice daily for a month. The average daily production for a "string" of cows varies from 6 to 10 10-gallon cans in winter and from 10 to 14 10-gallon cans in summer. On one farm one man, for more than a week, milked 22 10-gallon cans full a day.

Milking usually starts between 2 and 4 o'clock in the morning and the same time in the afternoon. Any work which can be done at odd times, such as throwing down feed and mixing grain, is done between noon and milking time in the afternoon. Small dairies, which do not require all of one man's time, are quite often cared for by the owner and his family.

Only a small percentage of the work was performed by women and boys, as shown in Table 6. The women did very little work around the barn, confining their efforts to washing utensils, which was done in the house.

OTHER COSTS.

Other costs include all charges on buildings, equipment, and cattle, such as interest, depreciation, upkeep, and repairs.

TABLE 7.—*Per cent relationship between other costs and capital invested.*

Item.	Buildings.	Equipment.	Cattle.	Total.
Capital invested	$54,647.14	$17,223.89	$108,679.00	$180,550.03
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Interest	7.0	7.4	7.0	
Depreciation	4.5	19.4	4.4	
Taxes	1.4		.9	
Insurance	.2			
Upkeep and repairs	3.1	.9		
Milking-machine repairs		.7		
Total	16.2	28.4	12.3	15.4

[1] Per cent of capital invested in the various costs.

BUILDINGS.

At the beginning of the work the buildings and silos were inventoried at their replacement value in normal times. Interest was charged on this value at the rate of 7 per cent. After the first inventory the subsequent values were determined by deducting from the

value at the beginning of the year the amount of depreciation during that year. The depreciation per year was based upon the remaining years of usefulness of the buildings. The average depreciation for the two years shows an annual depreciation of 4.5 per cent.

There were no direct taxes on buildings; but, since pasture figures were based on the raw or unimproved value of the land, it was necessary that the dairy should be charged with the taxes due to the improvements caused by the dairy buildings.

Insurance charges were taken from the receipts of the insurance companies.

A monthly account was kept of the money spent for such items as whitewashing, repairs on doors, etc.; but, to determine the amount necessary for painting, roofing, and such expenses which come less frequently, it was necessary to make an estimate on each dairyman's buildings of the amounts required yearly for such purposes. The total cost of upkeep and repairs amounted to 3.1 per cent of the capital value of the buildings.

EQUIPMENT.

The interest charge on equipment was 7.4 per cent of the inventory value of the equipment. Tools and equipment around a dairy barn are usually worn out quite rapidly, which explains the large annual depreciation of 19.4 per cent.

The charge for upkeep and repairs was 0.9 per cent and for milking-machine repairs 0.7 per cent. Supplies, such as gasoline, kerosene, washing powder, etc., amounted to 99 cents per cow per year.

New equipment purchased during the year was added to the first inventory before subtracting the second inventory.

CATTLE.

Milk produced by a purebred cow has no greater value than that produced by a grade cow. Raising purebred cattle is a separate business involving a greater investment and resulting in larger credits for calves. In this investigation the purebred cows were given values of grade cows of corresponding production and purebred calves were likewise given credits as grade calves from dams of corresponding production.

At the beginning and end of the year each cow was given an inventory value. The first value was based on the price at which the owner thought he could replace her. In order to avoid the influence of market conditions her subsequent value remained the same unless her owner thought that she had become a better or poorer cow.

Interest was figured at the rate of 7 per cent upon the investment at the beginning of the year.

To obtain the depreciation on cattle the value of every cow that entered the herd during the year was added to the herd inventory at the beginning of the year; from this result was subtracted the total value of the cows at the end of the year plus the prices received for cows sold during that year.

A depreciation of 4.4 per cent of the capital value of the cattle is shown. This figure would have been considerably higher had it not been for the large number of cows sold the last year for dairy purposes for which the dairymen received a very good price.

Taxes chargeable to the dairy were taken from the county auditor's tax books, and insurance was taken from insurance receipts.

Such items as veterinary fees, medicines, disinfectants, and cow-testing-association dues amounted to $1.45 per cow per year.

PER CENT COMPARISON OF FACTORS INVOLVED IN MILK PRODUCTION.

How did the cost of producing milk in winter compare with the cost in summer? What items were chiefly responsible for the wide variation in the seasons? These questions are answered in the following table:

TABLE 8.—*Per cent of the total costs represented by feed, labor, and other costs, by seasons.*

Item.	Winter.	Summer.	Entire year.
	Per cent.	*Per cent.*	*Per cent.*
Feed and bedding cost	36.6	7.3	43.9
Pasture	.9	11.6	12.5
Feed, bedding, and pasture cost	37.5	18.9	56.4
Labor cost	11.4	12.1	23.5
Other costs, except herd inventory variation	8.7	8.9	17.6
Total cost, except herd inventory variation	57.6	39.9	97.5
Depreciation on herd	1.2	1.3	2.5
Total cost of production	58.8	41.2	100.0

The first two columns show that the wide variation between the winter and the summer costs was due largely to the difference in the cost of feed and pasture. The combined feed, bedding, and pasture cost in winter was 37.5 per cent of the yearly costs, while the cost of these items in summer was 18.9 per cent. The fact that the labor cost in winter was 11.4 per cent and in summer 12.1 per cent shows there was a difference of only 0.7 per cent in this item for the two seasons.

The high prices received for cows sold during the year reduced the depreciation charge, and this item is reported separately, so its effect on the total cost can be seen.

The cost of producing milk in winter was 58.8 per cent of the yearly cost, while the summer cost was 41.2 per cent of it.

AVERAGE COMPARED WITH "BULK-LINE" COSTS.

During the last few years attempts have been made to use the average cost of production as a basis for determining the selling price of milk. Where the average cost basis is recommended it is evident that practically all those producers whose costs are above the average will find the profits reduced if they are so fortunate as not to suffer an actual loss. This will tend to discourage production and reduce the available supply.

In using the bulk-line method for determining a necessary price, only a certain number of the extremely high-cost producers may have costs above this price. The use of this method is illustrated in Table 9.

TABLE 9.—*Net cost, quantity, and per cent of milk produced by each herd, two winters and two summers.*

Winter 1917–18.				Winter 1919–20.			
Cost per 100 pounds.	Milk produced.			Cost per 100 pounds.	Milk produced.		
	Quantity.	Per cent of total.	Cumulative.		Quantity.	Per cent of total.	Cumulative.
	Pounds.	*Per cent.*	*Per cent.*		*Pounds.*	*Per cent.*	*Per cent.*
$1.91	67,036	4.2	4.2	$2.50	156,032	8.8	8.8
2.26	113,716	7.2	11.4	2.80	113,302	6.4	15.2
2.39	88,736	5.6	17.0	2.88	144,577	8.2	23.4
2.43	60,595	3.8	20.8	2.96	127,348	7.2	30.6
2.56	144,362	9.1	29.8	3.10	66,898	3.8	34.4
2.63	66,956	4.2	34.1	3.11	90,257	5.1	39.5
2.69	195,756	12.3	46.4	3.16	213,169	12.1	51.6
2.80	99,931	6.3	52.7	3.20	92,420	5.2	56.8
2.84	82,857	5.2	57.9	[1] 3.25			
2.86	131,097	8.2	66.1	3.30	202,567	11.5	68.2
2.89	113,785	7.1	73.3	3.31	56,349	3.2	71.4
[1] 2.91				3.48	54,677	3.1	74.5
3.02	48,222	3.0	76.3	3.50	62,631	3.6	78.1
3.29	91,896	5.8	82.1	3.60	100,453	5.7	83.8
3.47	112,754	7.1	89.2	3.83	39,680	2.2	86.0
3.59	80,523	5.1	94.2	3.95	113,973	6.4	92.5
3.82	61,283	3.9	98.1	4.01	79,539	4.5	97.0
4.85	30,126	1.9	100.0	4.61	53,581	3.0	100.0
Summer 1917–18.				Summer 1919.			
$1.06	174,306	7.5	7.5	$1.14	100,428	4.0	4.0
1.24	83,089	3.6	11.0	1.18	210,813	8.4	12.4
1.25	85,339	3.7	14.7	1.30	123,893	4.9	17.4
1.31	92,050	3.9	18.6	1.33	145,812	5.8	23.2
1.33	160,589	6.9	25.5	1.36	89,853	3.6	26.7
1.34	166,339	7.1	32.6	1.39	177,018	7.1	33.8
1.35	132,277	5.7	38.3	1.42	211,960	8.4	42.2
1.38	167,584	7.2	45.5	1.60	89,982	3.6	45.8
1.39	112,097	4.8	50.3	[1] 1.60			
1.40	213,498	9.1	59.4	1.62	309,716	12.3	58.2
[1] 1.50				1.64	98,174	3.9	62.1
1.53	63,466	2.7	62.1	1.70	102,351	4.1	66.2
1.57	462,128	19.8	81.9	1.74	89,637	3.6	69.8
1.65	112,066	4.8	86.7	1.77	167,586	6.7	76.4
1.93	136,413	5.8	92.6	1.79	92,741	3.7	80.1
1.95	125,893	5.4	98.0	1.87	132,253	5.3	85.4
3.48	47,846	2.0	100.0	2.03	98,741	3.9	89.3
				2.12	91,808	3.7	93.0
				2.32	175,642	7.0	100.0

[1] Average.

In Table 9, for the winter 1917–18, it will be noted that only 73.3 per cent of the milk was produced at $2.89 or less per 100 pounds, which is the first cost below the average cost of $2.91. In many sections this volume of milk would be an inadequate supply. On the other hand, 94.2 per cent of the milk was produced at $3.59 or less per 100 pounds. In order to include 98.1 per cent of the volume of milk, the cost advances to $3.82 per hundred, thus increasing the cost 23 cents per 100 pounds and adding only 3.9 per cent of the volume.

If the price of the milk were placed at $3.47 per 100 pounds, a profit ranging from 18 cents ($3.47 minus $3.29) to $1.56 ($3.47 minus $1.91) per 100 pounds would tend to increase the volume of milk produced by the more efficient dairymen. Similar deductions may be made from the other portions of the table.

MONTHLY DISTRIBUTION OF FACTORS IN MILK PRODUCTION.

A study of Table 10 shows that the per cent of milk produced each season did not vary greatly from year to year; however, there is a noticeable increase for both years in summer production over winter production. During the first year there was 19 per cent more milk produced in summer than in winter, and in the second year 17.4 per cent more was produced. The larger flow of milk in summer can be attributed to better pasture more than to any other cause.

With the exception of the month of November in the first year the feed, pasture, and bedding cost for the winter in both years was decidedly higher than in the summer. The same is true of feed and bedding cost minus the manure credit.

A study of the results of the two years' work shows that the feed costs for the first and second summers were 33.5 per cent and 33.6 per cent, respectively, of the total yearly feed costs. Likewise it is found that the summer production was 59.5 per cent and 58.7 per cent of the total production for the corresponding years.

TABLE 10.—*Monthly distribution of milk prices, milk sold and used, feed cost, and labor required.*

YEAR 1917–1918.

Month and season.	Income per 100 pounds of milk.	Income from milk sold and used.	Milk sold and used.	Feed pasture, and bedding cost.	Feed, pasture, and bedding cost minus manure credit.	Human labor.		Horse labor.	
						Per 100 pounds of milk.	Per cow.	Per 100 pounds of milk.	Per cow.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
November	$2.95	7.4	6.5	7.0	5.7	2.0	9.2	0.002	0.01
December	3.01	7.3	6.3	11.3	10.0	2.2	10.0	.008	.04
January	3.02	7.0	6.0	12.1	10.8	2.2	9.8	.011	.05
February	3.01	6.7	5.8	11.6	10.3	2.2	9.2	.014	.06
March	2.81	7.8	7.3	12.8	11.4	1.9	10.2	.011	.06
April	2.52	8.3	8.6	11.7	10.4	1.5	9.4	.005	.03
Winter	2.86	44.5	40.5	66.5	58.6	2.0	9.6	.008	.04

TABLE 10.—*Monthly distribution of milk prices, milk sold and used, feed cost, and labor required*—Continued.

YEAR 1917–1918.

Month and season.	Income per 100 pounds of milk.	Income from milk sold and used.	Milk sold and used.	Feed, pasture, and bedding cost.	Feed, pasture, and bedding cost minus manure credit.	Human labor.		Horse labor.	
						Per 100 pounds of milk.	Per cow.	Per 100 pounds of milk.	Per cow.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
May	$2.21	10.0	11.8	7.5	7.3	1.2	10.6	0.007	0.06
June	2.09	9.4	11.8	4.7	4.5	1.2	10.3	.009	.08
July	2.28	9.1	10.4	5.2	5.0	1.3	10.2	.012	.10
August	2.78	9.4	8.8	5.3	5.1	1.4	9.8	.005	.03
September	2.66	9.1	8.9	4.8	4.6	1.4	9.1	.006	.04
October	2.81	8.5	7.8	6.0	5.8	1.6	9.1	.033	.19
Summer	2.43	55.5	59.5	33.5	32.3	1.3	9.8	.011	.08
Year	2.61	100.0	100.0	100.0	90.9	1.6	9.7	.010	.06

YEAR 1919–1920.

November	3.19	7.0	6.3	10.6	9.9	1.9	9.7	.009	.05
December	3.28	7.4	6.5	11.9	11.2	2.0	11.1	.004	.02
January	3.65	8.3	6.5	12.0	11.4	2.0	10.8	.015	.08
February	3.33	7.0	6.0	11.2	10.5	1.9	9.5	.011	.05
March	2.82	7.3	7.4	11.9	11.2	1.7	11.0	.012	.07
April	2.47	7.5	8.6	8.8	8.1	1.4	10.6	.009	.06
Winter	3.08	44.5	41.3	66.4	62.3	1.8	10.4	.010	.06
May	2.35	9.3	11.4	5.1	5.0	1.1	11.1	.003	.03
June	2.43	9.6	11.3	5.1	5.0	1.2	11.3	.045	.43
July	2.62	9.9	10.8	4.6	4.5	1.3	11.7	.007	.06
August	2.94	9.7	9.4	5.1	5.0	1.4	10.4	.022	.17
September	3.04	8.8	8.3	5.7	5.6	1.4	9.0	.019	.13
October	3.12	8.2	7.5	8.0	7.9	1.6	9.5	.003	.02
Summer	2.71	55.5	58.7	33.6	33.0	1.3	10.5	.017	.14
Year	2.86	100.0	100.0	100.0	95.3	1.5	10.5	.014	.10

The number of hours required to care for a cow does not differ materially in summer and winter, but the number of hours required to produce 100 pounds of milk shows a marked increase from November to March, inclusive. This season corresponds quite closely to the months of intensive winter feeding, when the cows are kept in the barns or yards during the nights; it also corresponds to the months in which the smallest volume of milk is produced, and this fact exerts a great influence over the amount of labor required for producing 100 pounds of milk. This is more fully substantiated by the fact that during the months of May, June, and July we find the lowest time requirements for producing 100 pounds of milk because of the higher percentage of milk produced per month.

The small amount of horse labor was due to the use of motor trucks for collecting the milk and hauling it to market.

During the winter horses were used at some farms to haul the milk from the milk house to the road. In summer they were used for driving cows to and from the pasture; however, during July, August, and September, when the horses are hitched to the harvest wagon,

they were quite often used to haul milk or to get cans, because this method requires less effort than to carry or cart them. The high figure of 0.43 of an hour per cow for June, 1919, is chiefly due to one man who used a large amount of time cutting and hauling soiling crops.

SUMMARY.

A study of the results presented in this bulletin shows that 56.4 per cent of the total cost of producing milk was due to feed and bedding, 23.5 per cent to labor, 17.6 per cent to other costs, and 2.5 per cent to depreciation (see Table 8).

The requirements for producing 100 pounds of milk during the winter were: Concentrates, 29.4 pounds; hauling and grinding concentrates, $0.022; dry roughage, 92.9 pounds; succulent roughage, 143.3 pounds; bedding, 9 pounds; human labor, 1.9 hours; horse labor, 0.01 of an hour; other costs, $0.576 (see Table 1). Credits for winter production other than milk: Manure, 115 pounds; calves, 0.017 (see Tables 3 and 4). Requirements for producing 100 pounds of milk during the summer were: Concentrates, 5.2 pounds; hauling and grinding concentrates, $0.003; dry roughage, 7.5 pounds; succulent roughage, 40.4 pounds; pasture, 0.025 of an acre; bedding, 0.1 of one pound; human labor, 1.3 hours; horse labor, 0.015 of an hour; other costs, $0.406. Credits for summer production other than milk: Manure, 13 pounds; calves, 0.009.

The following items were provided for keeping the average cow one year: Concentrates, 1,187 pounds; hauling and grinding concentrates, $0.87; dry roughage, 3,336 pounds; succulent roughage, 6,474 pounds; pasture, $23.04 or 1.1 acres; bedding, 295 pounds; human labor, 121 hours; horse labor, 1 hour; other costs, $36.31 (see Table 2). Credits other than milk: Manure, 2.2 tons; calves, 0.97.

To keep a bull one year required 630 pounds of grain, 5,967 pounds of dry roughage, 3,069 pounds of succulent roughage, 43 pounds of bedding, and 40.4 hours of human labor. In addition, $13.56 was expended for pasture and $21.49 for other costs after a credit of $20.32 had been deducted for outside bull service.

During the winter men performed 89.8 per cent of the work and 86.2 per cent during the summer. The remaining labor was performed by women and boys (see Table 6).

Interest, depreciation, taxes, and similar charges against buildings, equipment, and cattle amounted to 15.4 per cent of the capital invested in them (see Table 7).

In the two years 44.5 per cent of each year's income from milk was obtained during the winter. The net feed and bedding cost for the first winter was 58.6 per cent of the net yearly feed and bedding cost, but during the second year the winter net feed and bedding cost was increased to 62.3 per cent (see Table 10).

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